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Abstract

Video games with zombies, which are infected creatures that attack humanity, thirst for human flesh and leave behind a human life of their own. Pop culture has glorified them in video games, but zombies are just repetitious; they rush forward to the players in an attempt to reflect their insatiable hunger. In doing so, zombies have the same motion, the same appearance, and the same challenge. Think; what if zombies still remembered the occupations that they had before the infection? Would it be possible for them to use their own profession to assault players in the video game? For example, a zombie, who used to be a chef, could kill players with his advanced knife skills. For that reason, players would have to disarm the zombie by cutting off his hands first. According to that idea, the players could fight against different zombies in different ways at each level. When the players face their zombies, they would be interested in unlocking new appearances and finding new weaknesses. As a result, the players would be more engaged and could become a part of the video game.

For this reason, I created a two-minute character demonstration to represent three, 3D professional, customized zombie characters that attack players in the zombie's own ways. Furthermore, I focused on highlighting their profession through attack motions rather than settings, but I do suggest that they are assimilated in their proper surroundings. In my thesis, zombie characters will include: (a) tailor using a scissors and needles, (b) a chef using knives, and (c) a lumberjack using a chainsaw as a weapon. I want the characters to be easily incorporated into existing video games with zombies to enhance the player experience.

Introduction

The Definition of a Zombie

Wade Davis (1985), in his book, *the Serpent and the Rainbow*, said that a zombie is a dead body revived by magic to act as a soulless robot in Haitian voodoo superstition. In voodooism, changing a human being into a zombie is one of the scariest ways to execute criminals. A sorcerer ensnares the victim by spreading poison from a puffer fish on his path, his belongings, and his food. The victim then comes in contact with the poison and lapses into unconsciousness. With magic, the sorcerer raises the unconscious body and forces him to work. He becomes a lethargic being under the sorcerer's control—without autonomic will.

There is someone, however, who changed the definition of a zombie to what we know today, filmmaker George A. Romero. He was the first to imprint zombies on the American culture with his movies. There were some zombie movies, such as *White Zombie* (1932) and *I walked with a Zombie* (1943), before Romero's time, but the zombies portrayed in the movies were listless and dominated by bocors—voodoo priests. However, it was Romero who defined a zombie as a corpse eating the flesh of human being.

The zombie character that George A. Romero created has been fully featured in many movies since that time. There have been numerous movies that borrow Romero's character since the *Night of the Living Dead* (1968). Features like *The Evil Dead* by Sam Raimi debuted on film in 1981. The story is of a group of travelers fighting against unidentified evils and the horrible dancing corpses portrayed earlier by George Romero. In addition to *The Evil Dead*, a great number of zombie movies, such as *Re-Animator* (1985), *The Return of the Living Dead* (1985), *28 Days Later* (2002), and *Resident Evil* (2002), have been produced with exciting returns at the box office. However, the remake of these movies is not enough to call a zombie character killer content for a video game. (Wikipedia, 2013)

Zombies in Video Games

Before the aforementioned zombie movies, the video game industry was universally in a terrible condition. The technology was not developed enough to realize the creators' ideas. Later, with the relentless march of technology, zombies played a huge role in developing the horror genre. Zombies also appeared outside of this arena in action, adventure, and shooter games. Players were as enthusiastic about these zombie games as the movie genre. Some of the most acclaimed games were even made into films. Among the most famous of the games were *Resident Evil* (1996), *The House of the Dead* (1996), and *Silent Hill* (1999). So what makes people excited by zombies?

Features of Existing Zombie Characters

Zombies look different from other movie monsters. First of all, a zombie maintains the shape of a human being while being immortal. Zombies are created by sprayed viruses in most zombie games. The viruses raise the dead, and they, in turn, attack the living. The people bitten by zombies are infected with the viruses, and the people who are bitten also become zombies to assail the masses. Since a zombie is a human being who once died, he/she has usually lost some body parts and roams around in tattered condition. Zombies used to be just ordinary people. They might have been someone's parents, siblings, and/or friends. However, they hardly recognize acquaintances and have a strange appearance after they are infected. I believe that this is the reason that people are terrified and, at the same time, fascinated by zombies.

A zombie is a walking corpse. The people bitten by zombies die right away and then are they raised from the dead as zombies because of the effects of the virus. They do not have free will; they only depend on the instinct of survival and, especially, their desire to eat people. That's why they attack the living. Zombies keep multiplying as long as the living humans exist. They symbolize the end of mankind. This makes the player feel invested in the

game, if only with hope to survive among the dystopia. The players feel like they have become heroes in fighting to save humanity—even as they sit comfortable in their reality. Unlike the zombies in films, the ones in video games are more uniform and repetitious. They are numberless and continue to attack until they are beheaded. Numerous zombies are produced randomly from just a few types of zombies. They cannot have totally different appearances and movements from each other because those effects increase the game's capacity and the time it takes for development to create more diverse types of zombies. This means that it is easy to eliminate the zombies once the players learn how to kill them. Therefore, the players will eventually get bored with fighting continuously against similar zombies. To solve this problem, there should be special zombies that portray as chief/boss characters or characters that are in charge of more minor characters. They are stronger and faster than general zombies. In addition, these bosses have a relationship with their different levels or stages, which, in many games, does not correlate. A player can hardly be absorbed in a story that does not make sense; therefore, through the project, I suggest a combination of original and creative zombie characters to remedy existing interactive shortcomings.

Methods

Features of the New Zombie Characters

The three zombie characters in the project were infected by viruses in their workplaces. However, they still remember their occupations because of their strong immunity. People have different levels of immunity and the characters were more powerful than any other. That is the reason why they did not forget their jobs even after the infection. Unlike the zombies that only depend on instinct, the ones in the project wear the professional costumes and attack people with their work tools. In layman's terms, professional personalities were given to them.

Since a zombie is the infected human being, his body is abnormal and modified. For example, a zombie's the left arm unusually bulks up and veins pop out. The arm's bone is broken because it cannot sustain the swollen muscles. With this terrible appearance, a zombie is recognized as the terror. Therefore, I included a lot of wounds and blood and exaggerated some parts of the bodies of the zombie characters to make them look as horrible as possible. The figures will bring out the liveliness as though they just came out from some battles.

The zombies are in the most common costumes of their occupations. They wear the same clothes as ordinary people because they were infected at work. Their clothes are worn out with age, torn from various battles, and stained with blood.

They are armed with their work tools, which help them make the most of their abilities. Just as a skillful carpenter is very handy with his chainsaw, people understand the features of their personal work tools more than any other person. Zombies' weapons are very bloody because they have recently killed people.

They attack people with the same motions that they use their work tools. For instance, the zombie chef brandishes his kitchen knives to kill people in just the same way that he cuts meat into large chunks. Therefore, players need to figure out different ways to kill the

zombies considering their occupations. Consequently, players get more absorbed in the games.

Procedures for Building Characters for Video Games

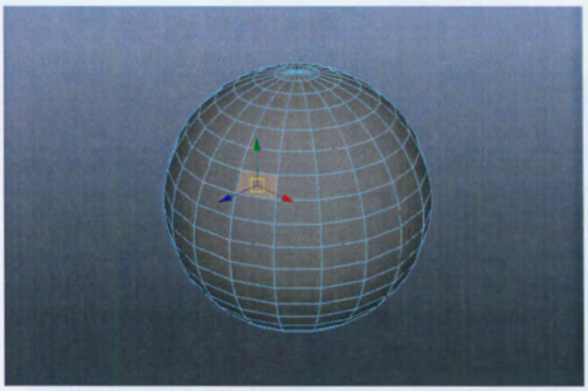


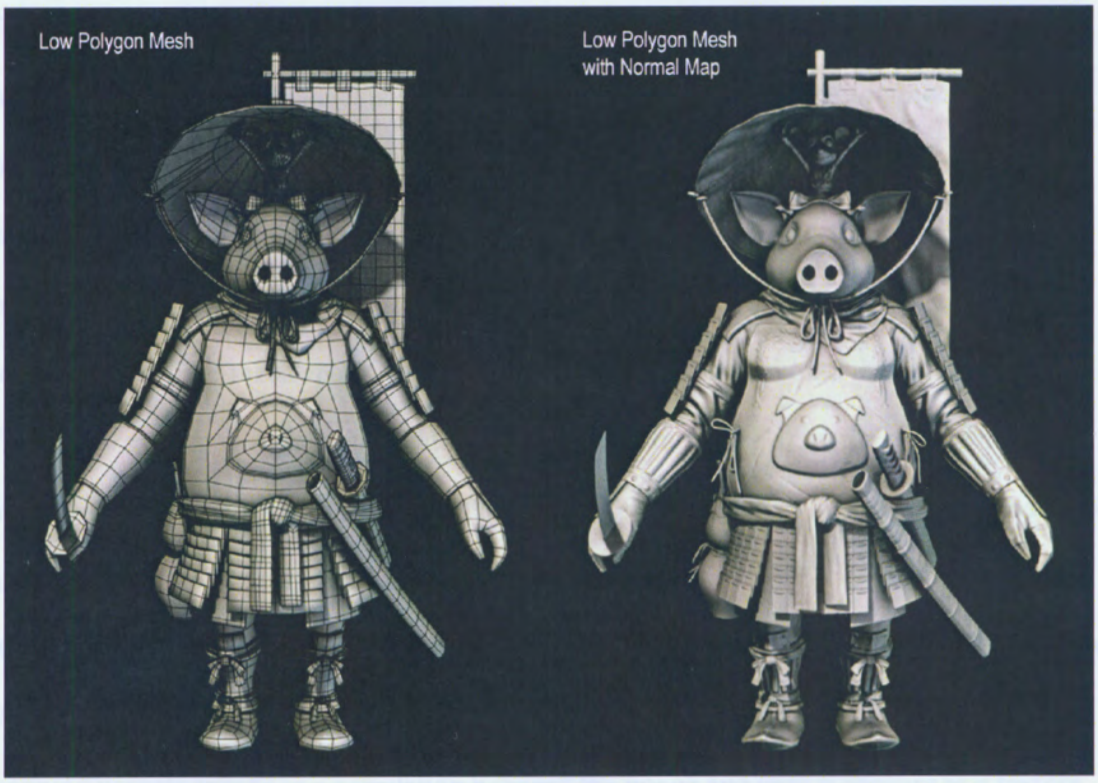
Figure 1. A polygon sphere

3D polygon modeling is the procedure to create a three-dimensional object using the software designed for this specific purpose. Most of 3D video games use 3D polygon modeling to create 3D objects. A polygon means a surface depicted in a 3D graphic. The 3D objects are called low, middle, or high polygon models according to the number of polygons used to build them. Unlike the high polygon modeling used in film and television, which require the highest quality of computer graphics, most video games use low polygon modeling because they render a lot of 3D objects simultaneously in real time. That is the reason the objects in video games have the least amount of polygons as possible. A low polygon character has less than 5,000 polygons while a high polygon character is able to have more than 10,000.

By the use of fewer polygons for 3D visualization, it is able to reduce the game's size, hardware requirements, and production lead time and cost. The low system requirements help the game secure more users. In addition to these advantages, more 3D objects can appear and more users can be playing the game at the one time

However, given that more polygons allow for the creation of more details in a 3D character, the weakness of a low polygon model is its lack of detail, and normal mapping is used to make up for that lack. Normal maps are usually produced in digital sculpting software

packages, such as ZBrush and Mudbox. Recently, traditional 3D tools, such as Maya and 3ds Max, also have the ability to extract normal mapping. The detail of a high polygon mesh is exported as a normal map, and a low polygon mesh with a normal map is assigned that looks like the high polygon mesh.



(a) (b)

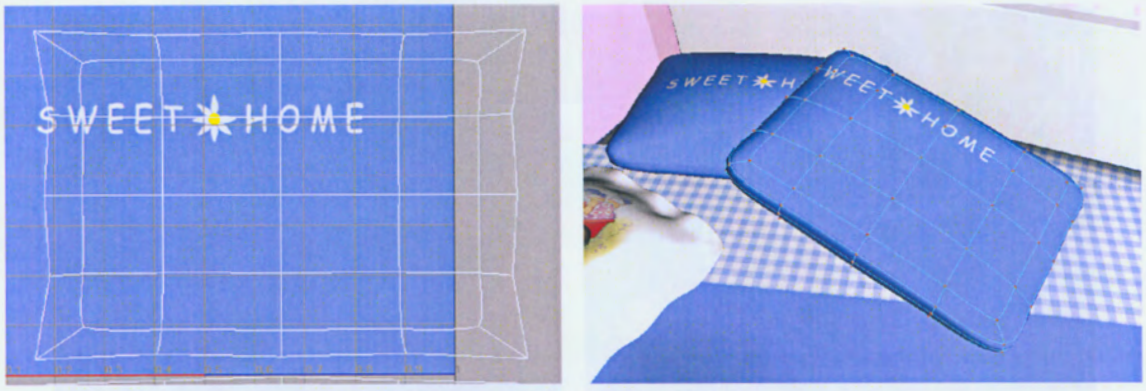
Figure 2. Images of (a) detail of a high polygon mesh exported as a normal map, and (b) a low polygon mesh with a normal map assigned to look like a high polygon mesh.

This method is not used only for computer games but also for games on seventh-generation consoles, such as PlayStation, Xbox 360, and Wii. Most console game developers use this method to create 3D characters.

Procedures for Building My Zombie Characters

I first built the low-poly geometries of the game characters in Maya. The number of the polygons used for the meshes should be as little as possible.

Secondly, I unwrapped the UV maps of the geometries in Maya. UVs (pronounced U-VEEZ) are two-dimensional texture coordinates that reside with the vertex component information for polygonal and subdivision surface meshes. UVs exist to define a two-dimensional texture coordinate system, called UV texture space. UV texture space uses the letters U and V to indicate the axes in 2D. UV texture space facilitates the placement of image texture maps on a 3D surface. UVs are essential because they provide the connection between the surface mesh and how the image texture gets mapped onto the surface mesh. That is, UVs act as marker points that control which points (pixels) on the texture map correspond to which points (vertices) on the mesh. Textures applied to polygon or subdivided surfaces that do not possess the UV texture coordinates will not render (*Maya User's Guide,* 2013). Texture mapping using the UV maps is called "UV mapping." To do UV mapping, the UVs have to be completely unwrapped and located on the right place of the map. The UV mapping process results in a correlation between the image and how it appears as a texture when mapped onto the three-dimensional surface mesh. UV mapping is a critical skill to master for accurate and realistic textures on polygonal surfaces (*Maya User's Guide*, 2013).



<UV mapping 1> Wrong UV mapping

<UV mapping 2> Right UV mapping

Figure 3. Right UV mapping

In a video game, numerous texture maps are applied to characters and environments. Therefore, it is very important to assign as few texture maps as possible to objects. To do so, all of the UVs of a character model should be jam-packed into one single texture map without empty spaces between them. Big, empty spaces mean that UVs are small, and they are unable to contain many pixels, so they make the texture map low in quality.

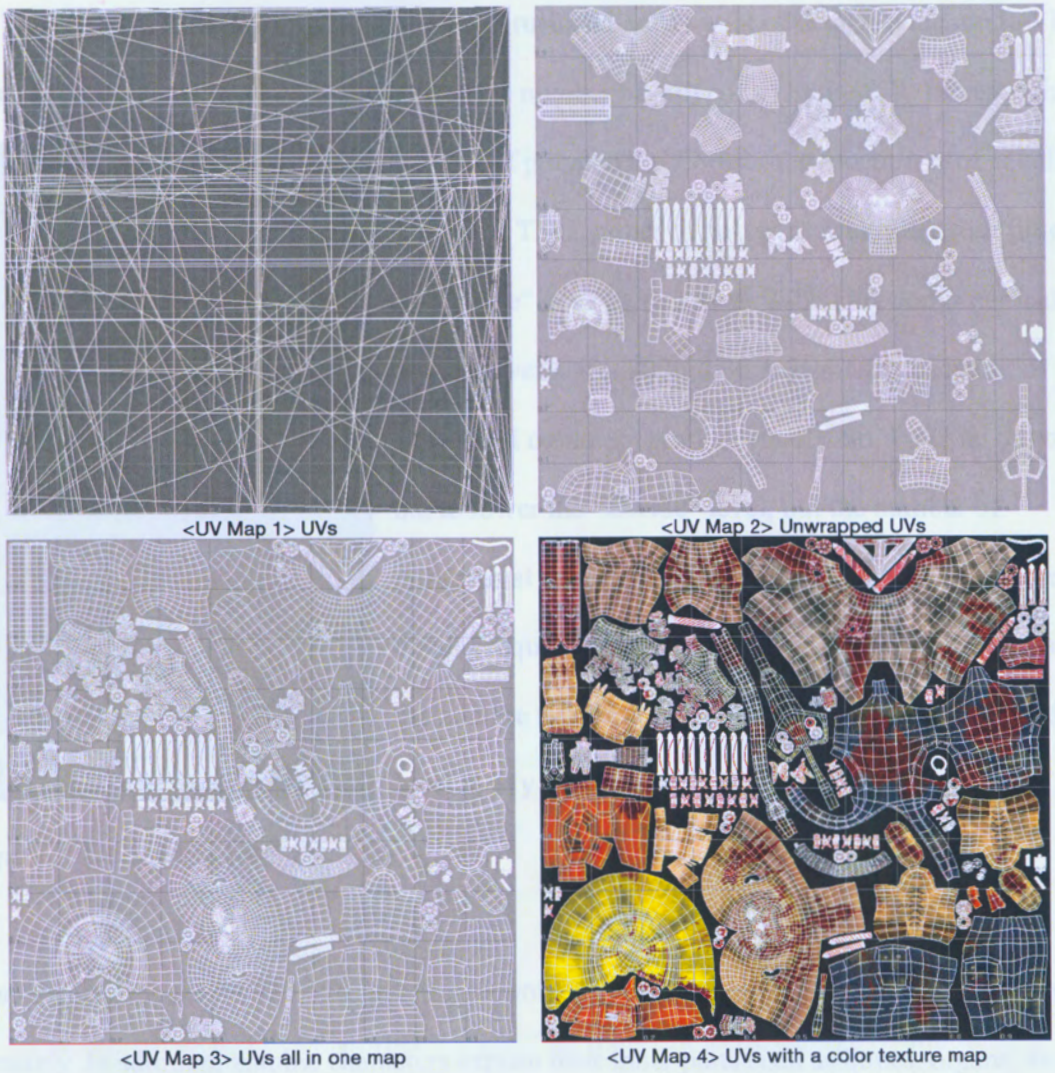


Figure 4. How to unwrap UV maps

Thirdly, I imported the model into Zbrush and added a lot of detail on the model. The more details created in Zbrush, the greater the number of polygons required. To increase the number of polygons in Zbrush, the function used is called "Divide." The number of polygons multiplies four times as "Divide" goes up one level. When my computer had to process over about 20 million polygons, it became so slow that I could not work normally. So, I had no option but to lower the "Divide" level, but the number of polygons at this level was not enough to create the fine detail I required. For instance, the number of polygons of the zombie tailor's torso object was 7,430,144 at Divide level 8. My computer was frozen at level 9, where the torso's polygons are 29,720,576. In order to work at level 8, I could not model the back bones minutely. In addition, zombie characters expose their inner parts such as bones, organs, and muscles. To figure out the shape and the structure, I had to research the references every time I created the inner parts. Other than the slow processing, the sculpting was the most interesting and enjoyable part in the process.

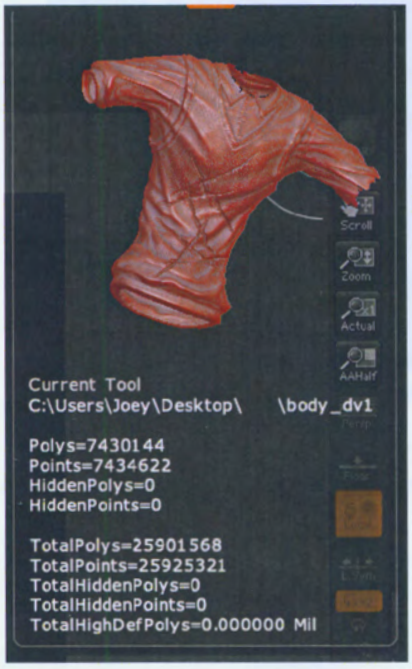


Figure 5. Devide level 8

Low polygon mesh in Maya

High polygon mesh sculpted in Zbrush

Figure 6. Sculpting meshes in Zbrush

Next, I exported the high polygon meshes as normal maps. The normal maps contained the information of the detail that was sculpted in Zbrush.

High polygon meshes will be exported as a normal map.

Figure 7. Exporting high polygon meshes as a normal map

Figure 8. Exporting high polygon meshes as a diffuse map

In the same way, texture maps, such as Diffuse, Transparency, and Specular, were also created in Zbrush. My zombie characters are all in blood-stained clothes. Therefore, when I painted the characters to create diffuse maps, I could enrich boring texture maps by simply putting blood textures on, so it was easy to create high quality textures of zombies as compared to those textures for other characters.

The process I used to create the blood texture on the clothes was as follows:

(1) I stamped a transparent blood texture a few times as a stain.

(2) I prepared many different kinds of blood textures, and stamped them on the stain to show enough blood soaked through the clothes.

(3) I painted darker colors on some spots of the blood to add more detail. I used blood textures in different colors according to the time-lapse exposure and the depth of the hurt because the blood that had coagulated is darker than fresh blood.

Fourthly, I created a Blinn material in Hypershade and assigned it to the model in Maya. After that, I applied all the textures that I had created in Zbrush to Blinn.

I connected the diffuse map to the Color attribute, the normal map to the Bump mapping, and the specular map to the Specular color.

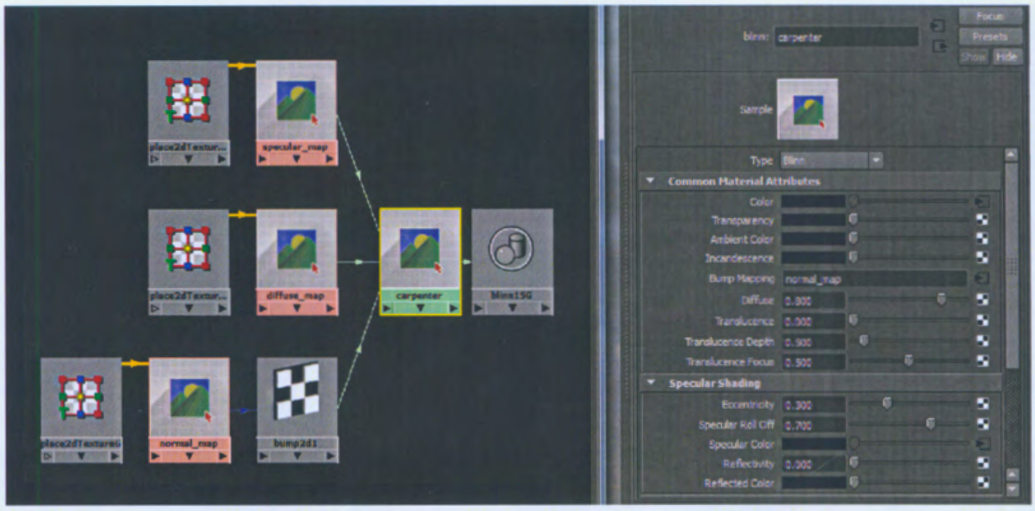


Figure 9. All the texture maps are assigned to the Blinn shader.

Lastly, when all texturing was done, I did rigging and animating of the characters. After creating the 3D models, I created low polygon models in Maya. It was simple to set an accurate weight of each vertex in the Component Editor. In addition, the low polygon modeling does not require a lot of video card memory, and Maya resists slow-down. I took advantage of timing animations in real time. When the Maya program is slow, it is very hard to check the timing of the animation in the viewport of Maya, and users may need to keep playing Playblast, which is the function to preview the current animation instantly, to check their animations.

Results

Chef

Figure 10. Chef

Personality. My first character is a chef. He is an Italian and his name is Bruno Colicchio. He has been working as a chef since he was nineteen. Now he is 47 years old and, as a chef, working for the restaurant that bore his name. He stands 5 feet 10 inches (1.77 meters) and weighs 250 pounds (113 kilograms).

He is extremely gluttonous and has a tough and inurbane personality. He is so far from cleanliness that his clothes are always dirty, and he does not like to clean up around him.

He is also very talkative, crafty, and always the leader in meetings with many people. He likes to be in the spotlight and surrounded by people.

He is married and has two sons who are college students. They are both majoring in the culinary arts, after their father.

Infection route. Bruno was infected at work by food that was carrying the zombie virus when he was working. He came under attack from seven co-workers as soon as he became a zombie. He got injured seriously in a battle but survived. After the battle, all of his co-workers were brutally eaten by him.

Costume. The chef zombie wears a traditional chef costume, apron, and rubber boots. The costume is covered with grime, sweat, and blood, and it is even hard to realize its original color. The jacket was torn from a battle so that his belly and back are totally exposed. My zombie characters are all in blood-stained clothes.

Weapons. According to the article in Recipetips.com (2013), the knives in his hands are a like cleavers. The knife has a wide rigid blade, which is approximately 6 inches in length and tapers to a sharp cutting edge. This knife is used to chop, shred, pound, or crush food ingredients and materials. The blade of the cleaver is thick, somewhat heavy, and well balanced with a beveled cutting edge. The beveled blade allows for ease of chopping through vegetables or hard materials, such as bones. The flat, blunt side of the blade can be used to pulverize meat. If the handle is flat on its end, it may be used to crush seeds, garlic or other similar ingredients. (Recipetips, 2013).

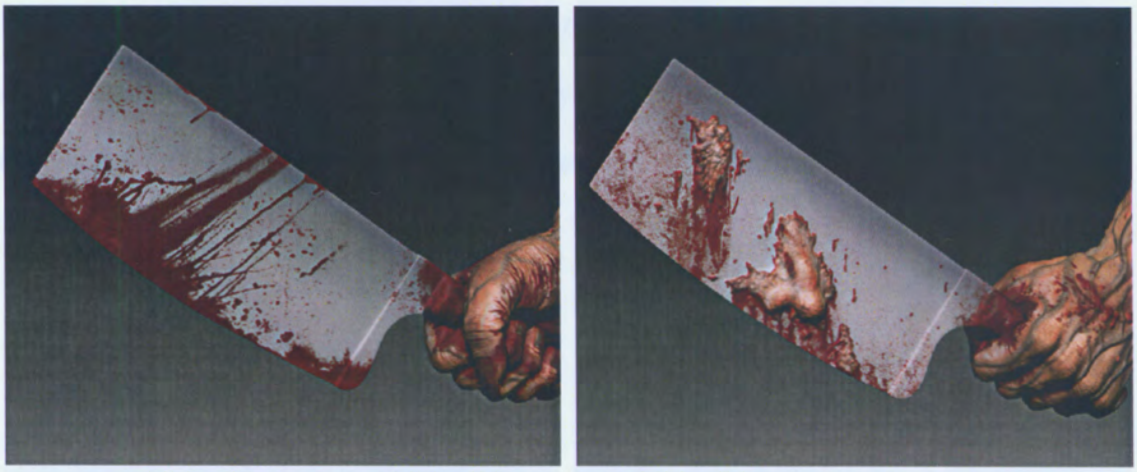


Figure 12. Knives on Chef's hands

In the battle with his co-workers, he picked the cleaver knife because he considered it the strongest. On one of the knives is a cut nose, which means that the cook cut someone's face lengthwise. A designer at Wikia, Eunsung Song (2012) said that the nose on the knife on the chef's left hand is his favorite part. He pointed out that the nose was a little too small and hard to be recognized as a nose, so it would be better to make the nose bigger. The chef grasped the knives so firmly that the veins on his arms are sticking out like the stems of ivy. Unlike a normal vein, his veins are grey, purple, and other dark colors because of the zombie virus in his blood. Bruno swings the knives around as he cuts food for cooking.

Injuries. The zombie virus has many different kinds of symptoms. For example, Bruno suffers from a skin disease that makes holes on the surface of his skin. He has a lot of holes on his whole body, especially face. The biggest hole is more than one inch in diameter. The holes are full of blood.

As I stated earlier, when he ate his co-workers, he roughly put them into his mouth without considering their size because he is a zombie, who is not able to feel pain. The chef's mouth was badly lacerated because their bodies were bigger than it. In addition, he did not separate their flesh from their bones but just chewed everything so that his teeth were broken.

He has only nine teeth left, and those teeth are not in good condition. They are not standing straight but are inclined to different sides of his mouth and the eight of his teeth, except for the lower right lateral incisors have holes in them.

Figure 13. Chef's head

His hat is torn in four locations. A part of his brain came out through one of the tears in the hat. In the battle with his co-workers, one of them hit the chef's head with a rolling pin. He had a skull fracture and his hat came off at the time. He put it on right away but the brain was released from the wound. The brain climbed up onto the hat like an octopus' leg. The hat never comes off— no matter how he moves—because the brain filling up the hat adhered to his hair and the inner cloth of the hat.

Figure 14. The knives on Chef's chest and back

There are ten kitchen knives embedded in his upper body. Five knives are in his chest and the rest are on his back. A large amount of blood flowed out from the cuts and wet his jacket. The knives that were stuck into his chest all have different textures. To create the knives, a knife built up in Maya was duplicated and located at different angles on his chest. After that, the knives were imported in Zbrush and textured separately. There are so many kinds of kitchen knives, depending on the method, shape, and material used. According to the article in Recipetips.com (2013), the knives on his body are a kind of chef's knife.

The chef's knife is also called a cook's knife and an all-purpose kitchen knife that is used for most types of chopping, dicing, mincing, and slicing. The chef's knives come in various lengths of 6, 8, 10, and 12 inches. The smaller sized knives are typically referred to as mini chef's knives, while the longer lengths are known as traditional chef's knives. The heft, weight, and balance of this knife allow it to be used for heavy-duty work with thicker cuts of vegetables, fruits and meats. The length of the knife is significant. The longer the knife, the heavier and more difficult it is to handle. Small handed cooks use shorter blades while large handed cooks prefer longer blades (Recipetips, 2013). As previously mentioned, his belly and back are totally exposed. Veins on his belly stand out much more than the ones on any other part of his body. The thickness of the veins is even one inch. As I said earlier, Bruno ate his enemies in the battle, but his stomach could not digest them. Therefore, they are still remaining in his belly. Because they were eaten alive, they, in pain, struggled desperately to get out of the chef's body. However, they were powerless to escape, and they eventually died within him. Their six faces stick out from inside and are shown on his belly. Eunsung Song (2012) advised that the people in the chef's belly could have more varied facial expressions.

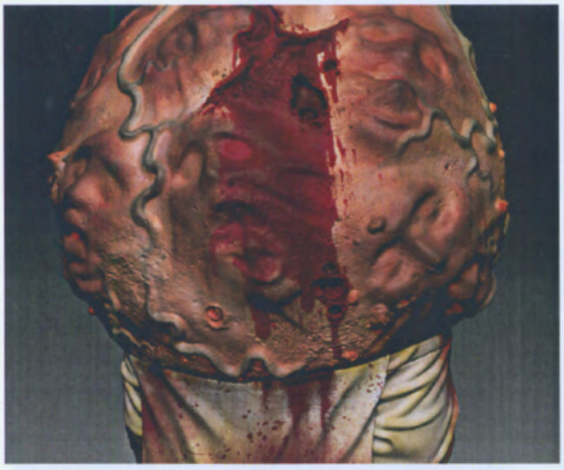


Figure 15. Chef's belly

He told me that the people have the same facial expressions, and it would be make the chef more interesting if I created more options for the facial expressions.

On Bruno's back, there is a manual meat grinder, which one of his fellow workers found and used to kill him after an unsuccessful search for a weapon. The colleague ground Bruno a little and was stopped soon after starting. However, the meat grinder is still on Bruno's body because his flesh is caught between blades in the meat grinder. The meat grinder is made of stainless steel and the grip material is wood. It has an entrance on the left side, a grip for one-handed use on the right side, and an exit of four holes is on bottom. The four holes have Bruno's ground flesh. On his body, around the meat grinder's entrance, is the texture that his skin is being sucked into the machine.

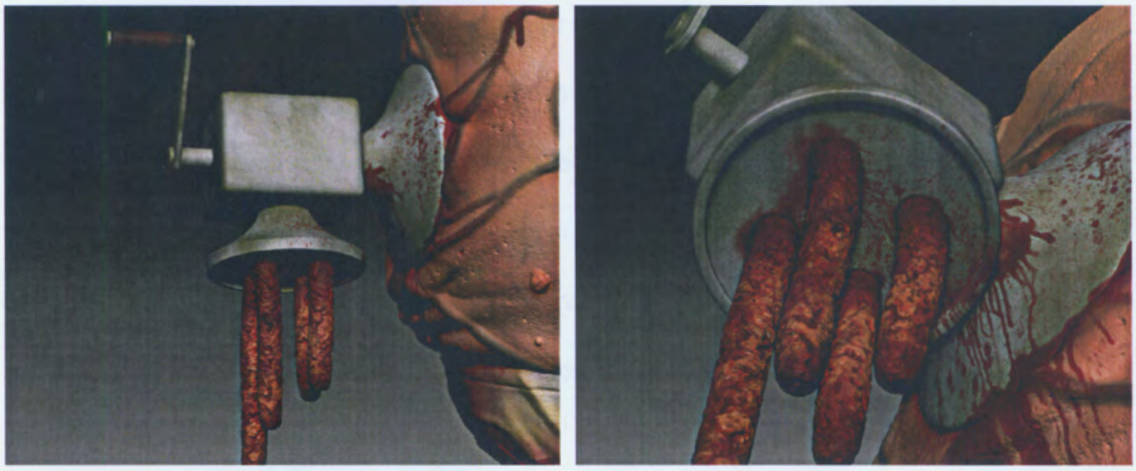


Figure 16. A meat grinder on Chef's back

My favorite design of the character is the meat grinder because I thought it was interesting that a human's body can be transformed to ground meat by the grinder. The process to create the ground meat was relatively easy, short, and efficient. First, I modeled a cylinder-shaped mesh in Maya and made holes randomly all over the mesh. Secondly, I connected the holes with engraving. Lastly, I cleaned up the edges between the engraving and the surface, and I added some details on the edges.

Finally, he lost a muscle in his left upper leg so that the inside of the leg is completely exposed. Among the leg's muscles, especially the biceps femoris and semitendinosus were damaged the most. He is no longer able to walk or run with the leg in that condition. The process to create the ground meat was relatively easy, short, and efficient. .

Weaknesses. The chef's weakness, ironically, is his enormous belly. As you can see, there are many people who were killed by him and not digested, yet they are inside his stomach. The people struggled in vain to escape so his organs and belly muscles were ruptured. Therefore, his belly is very weak and can be easily damaged from a little hit.

When Bruno attacks players, he runs to the players and then constantly brandishes his knives with them. It is really hard to deal with him in close range because of the speed of

his attack. No matter what weapon players use at close range, the damage they can inflict on the zombie is greater than the damage they can receive from him. It is also impossible to use tactics to avoid his assault and wait for a turn because there is very little delay between his attacks. On the other hand, it is very efficient to strike him at a distance because his running speed is very slow. Therefore, players should run far away from him and then launch a standoff attack. When he comes close, they should run away again.

Tailor

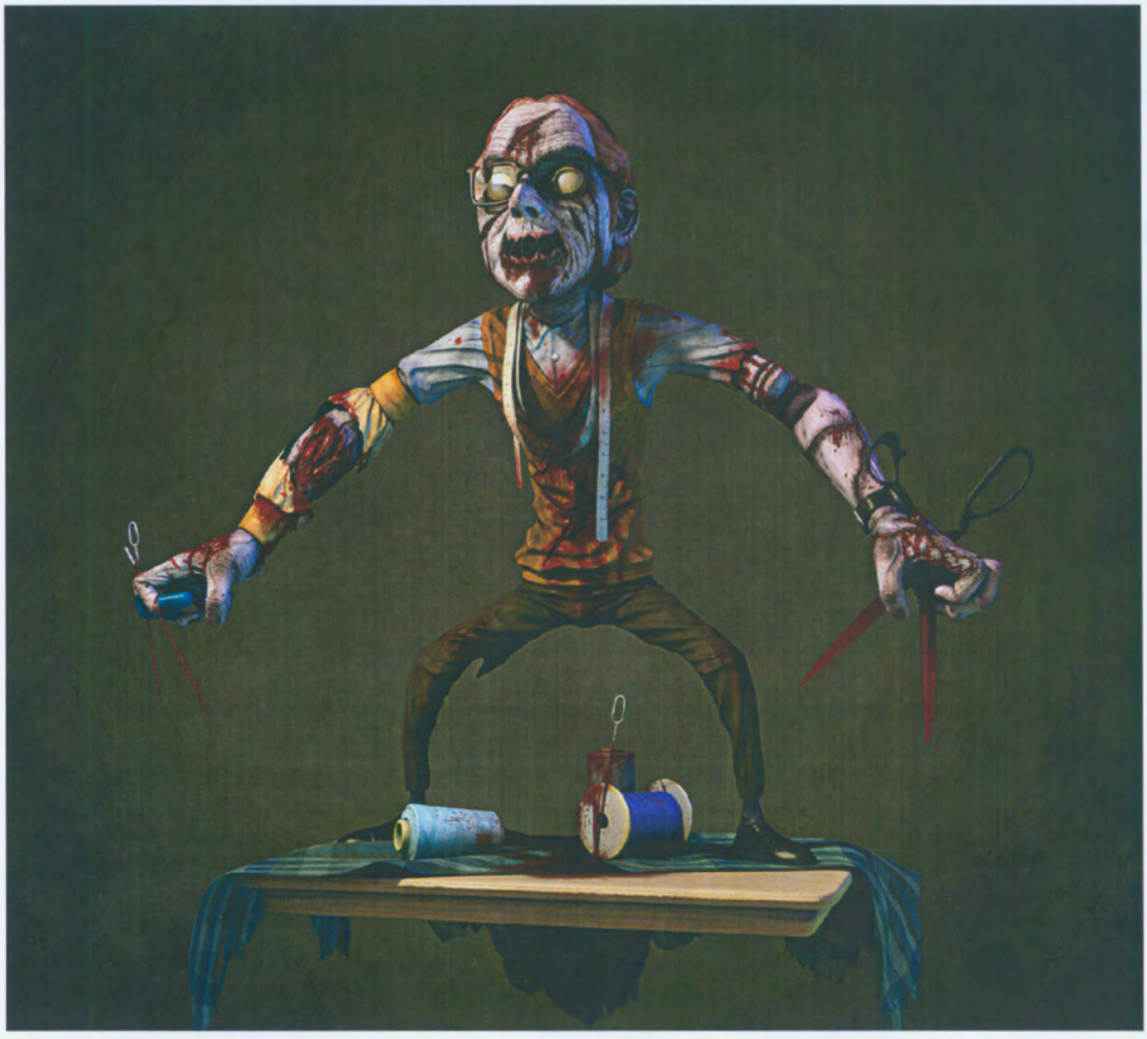


Figure 17. Tailor

Personality. My second character is a tailor. He is a French American and his name is Larry Parker. He is 55 years old. He has run his own tailor shop in a shopping mall for eight years. He is 5 feet 5 inches (1.68 meters) tall and weighs 121 pounds (55 kilograms). He is very skinny and has a small frame. He is very meticulous and good at his work, but he is notorious for penny pinching. He cannot deal household electric appliances, especially a computer. He has never been interested in music or dance but only in fashion. He likes to wear clean clothes in accordance with his age. He follows only his own rules in his

relationship to his work. In brief, he is a simple, honest fellow of the old form. He is still single and it is hard to see much chance of that he will ever get married.

Infection Route. Larry was infected by the zombies who assailed his shop. One day, a group of zombies raided the shopping mall and killed almost all of the people there. They also found Larry and his customers in the tailor shop very soon. They broke the glass door of the shop and got inside quickly without giving a chance to Larry to stop them. To protect his shop, the tailor tussled with the zombies. However, he was middle age and weak so his left arm and right leg were easily broken. One of the zombies ate off Larry's right leg so Larry got the zombie virus and became a zombie.

Costume. Larry has an eye for fashion and is normally a pretty sharp dresser. He wears a blue dress shirt, a vest with an argyle pattern, and brown formal slacks. Blue is a good color for the skillful and experienced specialists because it gives the image of respectability. He is wearing an arm protector to prevent his shirt from getting dirty. Larry also wears black leather shoes and a wristwatch, which has a black leather band, on his left wrist. His shoes had no dust and were glossy before being messed up by the zombies' assault. He has such poor sight that he wears black quadrangular horn-rimmed glasses. According to physiognomy, a rectangular shaped head represents a stubborn and thrusting personality. Therefore, the shape of his glasses symbolizes his personality. He has a measuring tape around his neck. To texture it, I made a 3D model, unwrapped the UV in Maya, and tried to put a texture map in Zbrush, just like the other character. However, it was impossible to put the texture of gradations on the tape measure in this way. Texturing in Zbrush is mostly either projecting or stamping. None of the texturing ways in Zbrush were working for the tape measure because the object was rounded while the gradations had to be correct and straight. Therefore, I built a straight measuring strap mesh having a straight UV in Maya, and then I easily created a texture of gradations based on the straight UV in Photoshop. After that, I

transformed the measuring strap according to the tailor's neck in Maya, and then assigned the texture map, which was created in Photoshop, to it in Zbrush. The glass of his watch was broken badly, and it is covered by his blood, so it is impossible to see the time on his watch.

Figure 18. Tailor's head

Weapons. In the fight against zombies, Larry held a zombie by its hair in his left hand and a pair of scissors in his right hand. He speared the zombie's head with the scissors violently and continuously. While he focused on how heavily to spear the head more than how accurately to do so, he pierced his own left hand with the scissors by mistake, and the scissors were embedded in his hand. Larry was suffering in agony, but he turned into a zombie who does not feel any pain. He embedded two needles into his forefinger and the middle finger of his right hand himself and utilized them as weapons.

He attacks people with the scissors embedded in his left hand and the needles in his right hand. Because he is so skinny and short, he is faster than any other and is able to rush to people at a high rate of speed. He tends to stab with his weapons rather than swing them.

Figure 19. Tailor's hands

Woosang Kim (2012), who is a 3D artist in South Korea, had an opinion that wrinkles on the hands were the best among details in the project. He also said that the wrinkles make the hands look quite realistic. I used my hands as the reference to make the wrinkles and tried to create as many as possible. I classified the wrinkles into three levels according to their depth. I sculpted shallow wrinkles on the entire skin first, and then I painted darker colors to express the depth of the deeper wrinkles.

Injuries. From the battle, Larry received serious injuries from the other zombie characters that I created in the project. He had many cuts on his face, and he sewed some of the cuts up by himself just after the battle. He also sewed his mouth under the illusion that his mouth was one of the cuts. Since his cuts were not delicately sewn, the thread holding the cuts loosened as he moved. Not only were the lenses broken but also the frames of his eyeglasses were broken.

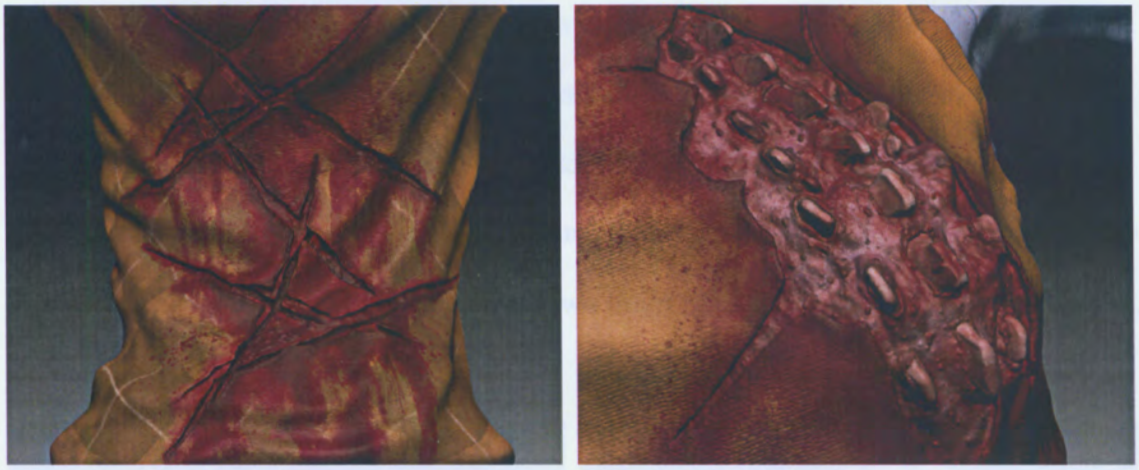


Figure 20. Tailor's chest and back

His clothes were all wet with large amount of blood that flowed out from cuts on his body. His belly was slashed by the tailor's scissors seven times from the upper part to the lower part of his belly. His backbone was broken, and seven joints of the backbone were exposed. He looks like a hunchback because of the broken backbone. Actually, he is no longer able to straighten his back. I consider that the detail on the back bones was not creative enough. To sculpt the detail, it was necessary to have about 10 million polygons. However, the torso object already had a lot of polygons when it was just a low-polygon model: the mesh had over 29,720,576 polygons in Divide level 9. The amount of polygons froze the computer, and that is why I had to work on Divide level 8, even though the number of polygons was insufficient. Now I think that I could separately create an object only for the back bones. If I did so, both the back bones and the torso would have sufficient polygons in a higher Divide level to create more detail.

The protector on the tailor's right arm was torn. In addition, the skin and muscles of his lower arm in the protector were shaved off badly. The muscles of lower arm, especially, the pronator teres, flexor carpi radialis, and palmaris longus, are revealed. They are the muscles that link the bone, the medial epicondyle, with the fingers. A part of the skin of his

right hand was gone as well. The first dorsal interroseus muscle, which connects the thumb with the index finger, and the superficial palmar branch of the radial artery are coming out from the wound. There are two needles embedded in his forefinger and middle finger. One finger has three bones, such as the distal phalanx, middle phalanx, and proximal phalanx. The needles penetrated the middle phalanx of the two fingers and are in parallel with it. Therefore, the needles work as a savage toenail.

Figure 21. Tailor's arms

Basically, his upper left arm was totally broken in the fight. Larry was supposed to sew the broken part to attach it to his body. However, he was not able to do that because he could not use both of his arms. Therefore, at first, he stitched the wounds well as possible. Second, he put the broken arm up to his shoulder and tied them together with a string. The knot was so tight and rough that the skin was raw and bloody where the string had rubbed. The skin of his left arm was shredded into many pieces, so he sewed them up like swatches of a quilt. The sewing to put them together was sophisticated enough to prove that he was a proficient tailor. As the needles are embedded in the fingers of his right hand, the scissors are in his left hand as well. The scissors penetrate his left hand vertically from the back to the palm of his left hand. Therefore, the scissors' thumb ring and finger ring are on the back of

the hand and blades are on the palm of the hand. The blades on the palm work like a bear's powerful forepaw. The hand also had a long stitched cut on the back of it. When the scissors penetrated the hand, he tried to pull it out but could not. At that moment, he became a zombie who lost control of himself, so he tore off the skin from the back of his hand.

Finally, Larry's right leg bone was broken and exposed. The muscles connected to the broken bone, such as the biceps femoris, semitendinosus, and semimembranosus, are also exposed. He bled a lot from the wound on his leg, but it not easy to notice because his slacks are brown, which is similar to dark red.

Figure 22. Tailor's leg

Former 3D artist at Ivedix, C. J. Carter (2011), believed that it would be possible to create more traces of fights on the tailor's costume. There should be some damage such as holes, tears, or raveling across the clothes. She also argued that I should avoid making tailor's costume symmetric, especially at the shoulders and thighs.

Weaknesses. The tailor's weakness is both of his arms. Actually he is middle aged and worn to a shadow so that his entire body is a weak point. However, players need to cut out both arms first. Larry will keep on rushing players even if his arm and leg are severed from his body. Therefore, attacking his arms is the best way to overpower him as soon as possible.

When Larry attacks players, he rushes while holding out both arms to the players so they can suffer a heavy blow if they go head to head with the tailor. It is also not easy to

target his small body when it is screened by his fast hands. For this reason, it is the best strategy to avoid his rush first and then to attack either his side or back. As you are able to notice from his little body, the delay between his attacks is not very long. Players need to focus on and assault him in the first moments. It will be easy to understand his movement if you think about the Korean character named Choi Bounge in the video game, *The King of Fighters* (1994) series.

Lumberjack

Figure 23. Lumberjack

Personality. My last character is a lumberjack. He was born in the United States and his name is Ryan James. He is 36 years old. He cuts trees down at Eagle Mountain in Minnesota. He has blond hair and a nice beard. His skin is tanned because he works under the open sky. He is 6.2 feet (189 centimeters) tall and weighs 243 pounds (110 kilograms). He is very muscular and has a firm body. He always thinks positively and finds satisfaction in the small things in his life. Contrary to Larry, Ryan is very mechanically inclined, and he knows well the workings of machines and cars, and he is able to maintain them by himself. He is

such an expert, especially on his chain saw. He plays the guitar as a hobby, and he takes a trip with his family on holidays. He got married relatively early and has a ten-year-old daughter in fifth grade.

Infection Route. One day, Ryan was cutting trees with his colleagues at Eagle Mountain. There were worms spread around him, and they were infected by a zombie virus. Actually, some zombies died at the mountain before Ryan came. The worms ate the zombies and were infected at that time. Ryan did not recognize that the worms were right next to him. The worms quickly made holes in Ryan's body and got into it. They wandered inside his body and ate away at it. He was infected by the worms and swung his chain saw at his co-workers. His colleagues resisted with nail guns, but they were immediately torn apart by Ryan's chain saw.

Costume. Ryan wears a cotton plaid shirt and denim bib overalls. The plaid's colors are bright and dark grays. His sleeves are rolled up as usual. The overalls have a big pocket on the chest, which is split into four sections. In addition to the pocket, there are more pockets on each leg and hip. The overalls also have orange stitches on every edge. Woosang (2012) believed that the yellow stitches helped to increase the quality of the overall, and it would be boring without the stitches. Some parts of the overalls were worn out. He has a tool bag on his waist. There is a set square, a pen, a handkerchief, and a Phillips screwdriver in the bag. A hammer is hanging in the loop attached to the bag. He is right handed; therefore, his tool bag is located on his right leg, so that he is able to use the tools in the bag easily. He also wears a yellow hard hat, black leather gloves, and beige boots. These function as safety equipment. Lumberjacks must wear hard hats to protect their heads. The outer material of the helmet is reinforced plastic, and the inside is expanded polystyrene with a strap to secure the hat onto his head.

Yellow is the general color, but white and khaki are also used. The hat appears in video games frequently and represents simplicity, ignorance, and firmness (*Enhawiki Mirror*, 2012). For example, the character in the hard hat is Metool in the *Mega Man* (1987) series. Lumberjacks are always wearing leather gloves in case of accidents. Ryan uses an electric saw and touches trees all the time. In addition to the hard hat and gloves, he is also in Timberland yellow boots.

Figure 24. Lumberjack's boots

Timberland is the original yellow boots maker. In 1973, Nathan Swarty founded Timberland and released work boots for workers in agriculture and forestry for the first time. The yellow boots' soles are waterproof and have a soft inner layer. However, against all expectations, the shoes gained popularity with young people who wanted a tough and natural image in 1970s (The Timberland Company History, 2003). For the reason, the lumberjack is wearing Timberland boots.

When the character is wearing a lot of clothes, using just solid-colored textures will make him look boring. Diversifying the kinds of textures and materials of the clothes can increase the quality of the character. For example, the lumberjack wears a solid colored

helmet, shoes, and overalls. To add variety, I put a plaid texture on his shirts to avoid monotonous colors.

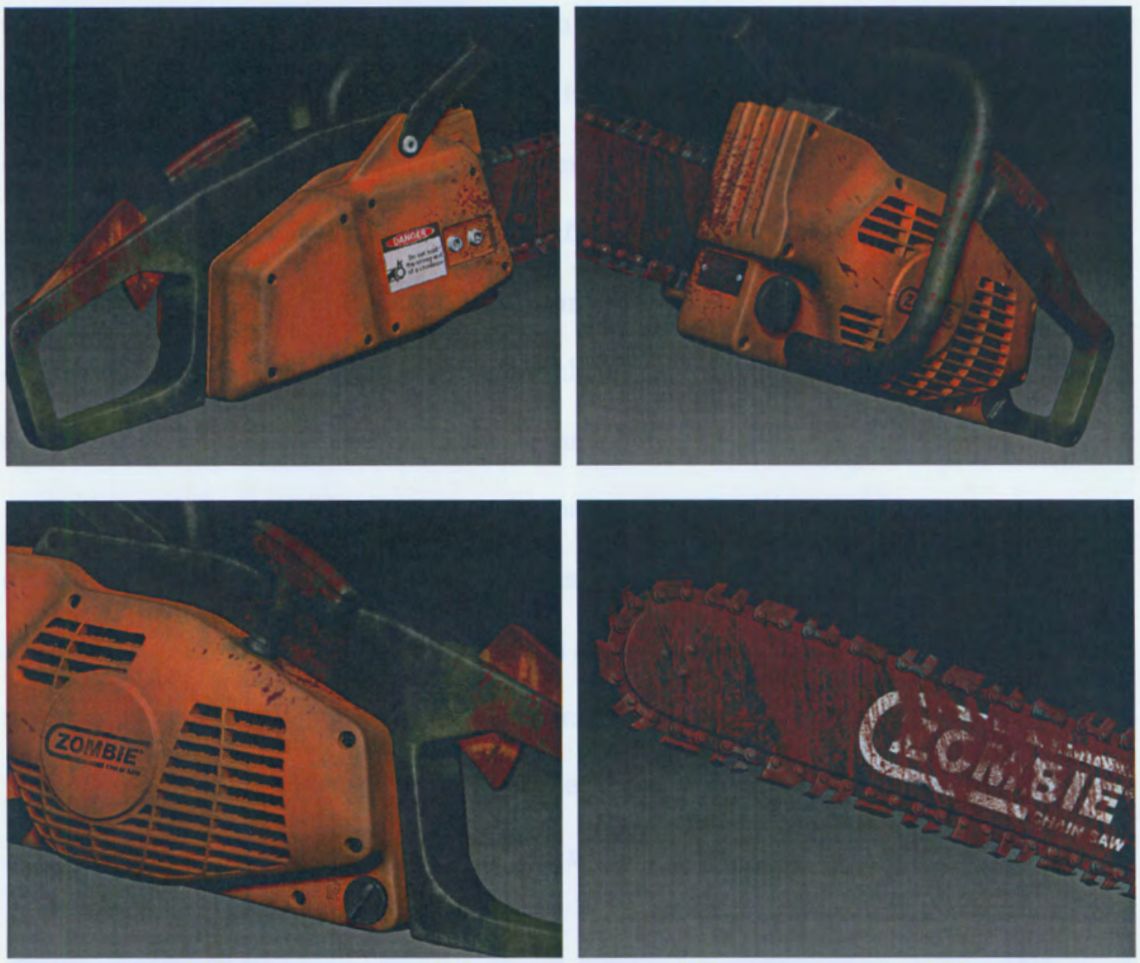


Figure 25. Lumberjack's chain saw

Weapons. The chain saw on his left hand is the most powerful among his weapons. It is so easy to cut a human being because he is basically strong, and he used to cut down huge trees. He can slice a human being's waist into two in one motion. Because of the heavy and vibrating machine, his arm muscles are more developed than any other muscle on his body. The chain saw he has is a very general gasoline-driven one. The power saw offers a 33.4 cc high-performance, 2-stroke engine. Its body and buttons are orange, like Echo's chain saws. His 18-inch chain is steeped in blood because he just killed human beings with his

chainsaw. The chain saw has ventilation ducts that consist of a lot of holes. I created the ventilation ducts in Zbrush to reduce the number of polygons, and it was quite hard and tedious. I put an object over the chain saw with another object and then subtracted it from the chain saw to make the same shaped hole as it. However, the flow of the polygons on the chain saw was not straight, so that the cut edges were rough. Therefore, I had to clean up and straighten the edges. It took a lot of time and effort because the holes were made one by one. The chain saw has a lot of teeth on the blade, and I created them in separate pieces. If the carpenter was in the existing video game, the chain saw would be in one piece. However, the reason I created the teeth of the chain saw separately was because I wanted to enhance the quality to as high as possible. Consequently, the number of polygons of the character went up quite a bit, but the details of the teeth of the chain saw got much better.

His right arm with a lot of nails in it is also used as a weapon when he swings. The nails were from the nail guns that his coworkers shot at him. Ryan blocked the flying nails with his arms. His arms are now working as the spiked baseball bat in *Dead Rising 2* (2010). In the game, the bat is crafted after combining a baseball bat and a box of nails.

Figure 26. Lumberjack's head

Injuries. Because of the infection from the worms, Ryan has a lot of holes in his face and ears. As I mentioned above, the worms ate his body's insides, and the holes occurred as they they moved through it. His safety cap was broken by the nails that his coworkers shot. There are four nails embedded in the helmet, as well as in his skull. Actually, the nails shot at Ryan were not four, but five. The other one that you cannot see broke the left back side of the hat and then was embedded in his skull. However, the area of the skull around the nail could not resist against the shock, so the fracture of the skull fell out with the nail. That is the reason why a part of his brain appears.

Figure 27. Lumberjack's helmet

He also got nail gun shots on the left side of his chest and the right side of his abdomen. Worms got into the holes easily and ate his organs and the undigested food in them. The worms became much bigger than any other worm inside his body. You can see the giant worms that come out of the holes. They make a large inner path to connect the hole on the left side of his chest and the one on the right side of his belly. The worms were created by me for this project. C. J. Carter (2011), who is former 3D artist at Ivedix, advised me that the character design could be more interesting by creating different kinds of worms. The worms were all covered by blood, so that it is not possible to know what their original colors were.

Therefore, I think that it would be better to show some parts of the worms without blood and paint some complementary colors such as green and blue.

Figure 28. Lumberjack's torso

The left shoulder belt of his overalls was broken by the nail gunshot which made a hole on the left side of his chest. There are more than ten nails embedded in his right arm, and blood is gushing out from the wounds. Since his coworkers were surrounding him to shoot, the nails embedded in his right arm are in all directions. His left foot also has three nails in it. Therefore, most wounds he has are not by any physical fight, but by nail gun shots and worms. That is all because of his strong physical structure.

Figure 29. Lumberjack's arms

Weaknesses. Ryan's weakness is his neck. It is not easy to kill him by attacking just his body, which is as strong as hard steel. His neck is such a small area on his body, so that he is harder to kill than either the Chef or the Tailor. Even if the players hit his head, which is the general weakness of monsters in video games, he does not receive any damage as long as he is has his safety helmet on. The neck is one of the weakest parts on the body. There are approximately fifteen vital points on the neck and they cannot be strengthened. The neck has important nerves, blood vessels, and the spine. Therefore, it is very easy for the neck to get injured seriously.

Ryan swings his chain saw twice to the players when he attacks them. There is a few seconds' delay right after he swings. That's the best time to strike his neck. When he brandishes the chainsaw, there is very little chance of hitting his neck. It is because his body is moving and is naturally guarded by the chainsaw. He is basically slow, so the players will be able to find the right moment to attack his neck easily. However, it is very important to note that the players will received some get serious damage if they do not avoid the powerful lumberjack's chainsaw.

Conclusion

Zombie characters totally lose their humanity, but they repeatedly attack, especially in video games. Players lose interest because their zombies have the same appearance, the same behaviors, and the same weaknesses. For technical and financial reasons, most game developers create just a few different low-level zombies and produce them randomly throughout the game. I believe there is an opportunity to create zombie characters akin to their scenarios to arouse a player's interest. Inspirations from movies like *Day of the Dead* (2008) informed the concept of zombie characters with occupations. These occupations explain their costumes and how they attack. This inspires a player to deal with each zombie strategically, depending on their profession and way of attack.

With these ideas, I created three zombie characters. As most zombies in 3D video games, each character was initially built with the software, Autodesk Maya 2010. I then sculpted every detail on the base models through Pixologic Z-brush 3.5. After completing the models, I rigged and animated them in Maya. The first zombie I built was the Chef zombie, Bruno Colicchio, who was infected by the zombie virus through some food he was working with. Bruno suffered a skin disease that ate holes in his skin, and the sores were filled with his blood. He attacks players with knifes on both hands as he cuts food for cooking. Players have to assault his weakened belly, which is full of the people who were eaten and have struggled in vain to escape from his organs. The second character was the tailor, Larry Parker, who was infected by zombies that assailed his shop. He was stabbed several times across his body, and his left arm and right leg were broken and bandaged. He attacks players with the scissors and needles embedded in his left and right hands. The strategy to defeat him is to cut off both of his arms. The last zombie I created was the lumberjack, Ryan James, who got the virus from infected worms in the mountains. His coworkers shot him with nail guns after he became a zombie. He swings his chain saw at players as he cuts trees. It is very hard to take

him down because his body is as strong as steel, but his neck is very weak. Like these zombies, the characters of distinct individuals in well-knit scenarios help people to become more interested in the video game and that increases the degree of completion throughout their game.

As each movie or drama has its own definition of a zombie to be successful, so does each video game. Caricatured zombies in *Left 4 Dead* (2008) developed by Turtle Rock Studios (Valve Corporation) gained great popularity. On the other hand, *Land of Dead* (2005), developed by Brainbox Games, received poor evaluations from players. The game's doctor zombie was a boss character wearing a white gown, but he still was brandishing an axe. Recently, many game companies are endeavoring to create individual zombie characters. In this project, I gave occupations to the zombies and their attack styles such as the lumberjack cuts players with his chainsaw. To continue developing this project, it is necessary to research various jobs and the types of jobs that would be interesting when concatenated with the professional attack techniques.

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